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I, Svetlana Saitsky, hereby certify that the following is, to the best of my knowledge and belief, a true and accurate translation of the following document [Q88611; Japanese Patent 2004-287041] from Japanese into English.

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(54) **(Title of invention) Image display device and light source unit**

(57) (Abstract)

(Problem) To ensure a bright image and reduce cross-talk in liquid crystal type stereoscopic image display. Also, to obtain a wide viewing angle.

(Solution means) An image display device comprising a filter provided with first areas that transmit light of a specified polarization and second areas that transmit light of polarization orthogonal to the specified polarization, repeating in the vertical direction, and a light source 201 comprising a light emitting source 210, a polarizing means 212 that outputs the light from the light emitting source as light of the specified polarization and light of polarization orthogonal to the specified polarization, and an optical means 203 that refracts the lights of different polarization in the directions leading to the left and right eyes and irradiates the lights onto a liquid crystal display panel 205, wherein the light emitting source 210 is a linear light emitting source that has a light source part for stereoscopic image display in the central portion and light source parts for viewing angle enlargement at both end portions, and emits light linearly; central prisms 306a, which increase brightness by narrowing the irradiation range of the linear light emitting source, are provided in the central portion the linear light emitting source; and peripheral prisms 306b, 306c having a different brightness from the central prisms 306a are provided at both end portions of the linear light emitting source.

(Selected figure) Figure 1

[see source for figure]

(SCOPE OF PATENT CLAIMS)

(CLAIM 1)

An image display device comprising:

a liquid crystal display panel that can transmit light irradiated from behind;

a light source that irradiates a light of a specified polarization and a light of a polarization orthogonal to said specified polarization onto said liquid crystal display panel; and

a filter disposed between said liquid crystal display panel and said light source and provided with first areas that transmit light of said specified polarization and second areas that transmit light of polarization orthogonal to said specified polarization, repeating in the vertical direction;

wherein said light source comprises a light emitting source that emits light of no specified polarization; a polarizing means that outputs said light with no specified polarization as light of said specified polarization and light of polarization orthogonal to said specified polarization, and an optical means that refracts the lights of different polarization in the directions leading to the left and right eyes and irradiates the lights onto said liquid crystal display panel,

said image display device characterized in that

said light emitting source is a linear light emitting source that is disposed laterally with respect to the liquid crystal display panel with the light source part for stereoscopic image display in the central portion and the light source part for viewing angle enlargement at both end portions, and that emits light linearly;

central prisms, which increase brightness by narrowing the irradiation range of said linear light emitting source, are provided in the central portion of said linear light emitting source; and

peripheral prisms having a different brightness from said central prisms are provided at both end portions of said linear light emitting source.

(CLAIM 2)

The image display device described in Claim 1, characterized in that said linear light emitting source comprises a plurality of linearly disposed point light emitting sources, and said central prisms and said peripheral prisms comprise, in a one-to-one relationship to the point light emitting sources, a light input surface that allows light from said point light emitting sources to enter and a light output surface that outputs light that has entered through the light input surface and whereof the optical path has been corrected.

(CLAIM 3)

The image display device described in Claim 2, characterized in that the light output surfaces of said central prisms and said peripheral prisms are formed without any gap therebetween.

(CLAIM 4)

The image display device described in Claim 2, characterized in that said central prisms and said peripheral prisms are provided in a one-to-one relationship with respect to said point light emitting sources.

(CLAIM 5)

The image display device described in Claim 2, characterized in that said central prisms and said peripheral prisms are provided separately for the central portion of said linear light emitting source and the two end portions of said linear light emitting source, and are formed integrally via the peripheries of the light output surfaces according to the required number of point light emitting sources.

(CLAIM 6)

The image display device described in any one of Claims 2 through 5, characterized in that said point light emitting sources are arranged at a high density in the central portion of said linear light emitting source and at low density at both end portions of said linear light emitting source.

(CLAIM 7)

The image display device described in any one of Claims 1 through 6, characterized in that said central prisms and said peripheral prisms are fashioned as wedge shaped prisms having a light input surface facing said point light emitting sources and a light output surface facing the liquid crystal display panel surface, wherein the shape of at least one of the opposing side surfaces of said wedge shaped prism with respect to the liquid crystal display panel is made into a curved surface.

(CLAIM 8)

The image display device described in Claim 7, characterized in that the shape of the other of the opposing side surfaces of said wedge shaped prism is made into a flat surface.

(CLAIM 9)

The image display device described in any one of Claims 1 through 6, characterized in that the light output surfaces of said central prisms and said peripheral prisms are formed so as to be located substantially equidistantly facing the central portion of said liquid crystal display panel.

(CLAIM 10)

A light source unit that comprises a light source part for frontal viewing in the central portion and a light source part for view field enlargement at both end portions, and that linearly emits light, and irradiates light from behind onto a liquid crystal display panel via an optical means that refracts light and irradiates it onto the liquid crystal display panel, characterized in that
central prisms, which increase brightness by narrowing the irradiation range of said linear light emitting source, are provided in the central portion of said linear light emitting source; and
peripheral prisms having a different brightness from said central prisms are provided at both end portions of said linear light emitting source.

(DETAILED DESCRIPTION OF THE INVENTION)

(0001)

(TECHNICAL FIELD OF THE INVENTION)

The present invention relates to a liquid crystal type image display device light source unit and image display device.

(0002)

(PRIOR ART)

In the prior art, three-dimensional image display devices had a configuration wherein a polarizing filter part for the right eye and a polarizing filter part for the left eye, having orthogonal polarization directions, are arranged on the left and right of the front surface of a light source, the light passing through each filter part is made into parallel light by a Fresnel lens and irradiated onto a liquid crystal display element, the polarizing filters on the two sides of the liquid crystal display element have orthogonal linear polarizing filter line parts alternately arranged on each horizontal line, the opposed linear polarizing filter line parts of the light source side and viewing side have orthogonal polarization direction, and video information for the right eye and for the left eye is alternately displayed on the liquid crystal panel of the liquid crystal display element on each horizontal line in accordance with the light transmitting lines of the two polarizing filters. Such devices also had a configuration wherein the light source side polarizing filter has orthogonal linear polarizing filter line parts alternately arranged on each horizontal line, the viewing side polarizing filter is made into a linear polarizing filter having one of the linear polarizing filter line parts of the light source side polarizing filter, and video information for the right eye and for the left eye is alternately displayed on the liquid crystal panel of the liquid crystal display element on each horizontal line in accordance with the light transmitting lines of the light source side polarizing filter (see for instance Patent Literature 1).

(0003) (PATENT LITERATURE 1)

(Patent literature 1)

Japanese Unexamined Patent Application Publication H10-63199

(0004)

(Problem to be solved by the invention)

However, in a conventional image display device as described above, since there is a large number of polarizing filters and the like, and the light source is a so-called point light source in which the light source is arranged only at the center behind the liquid crystal panel, there were difficulties with regard to the brightness of images. Furthermore, while the light from the light source is converted into parallel light for the left eye and parallel light for the right eye via the Fresnel lens, there exists cross-talk where these lights overlap, and to that extent, the stereoscopic image becomes difficult to recognize. Moreover, there was the problem that the horizontal viewing angle is narrow.

(0005)

The object of this invention is to provide a light source unit and an image display device in which these problems are resolved.

(0006)

(MEANS FOR SOLVING THE PROBLEM)

The first invention is an image display device comprising: a liquid crystal display panel that can transmit light irradiated from behind; a light source that irradiates a light of a specified polarization and a light of a polarization orthogonal to said specified polarization onto said liquid crystal display panel; and a filter disposed between said liquid crystal display panel and said light source and provided with first areas that transmit light of said specified polarization and second areas that transmit light of polarization orthogonal to said specified polarization, repeating in the vertical direction; wherein said light source comprises a light emitting source that emits light of no specified polarization; a polarizing means that outputs said light with no specified polarization as light of said specified polarization and light of polarization orthogonal to said specified polarization; and an optical means that refracts the lights of different polarization in the directions leading to the left and right eyes and irradiates the lights onto said liquid crystal display panel, wherein furthermore said light emitting source is a linear light emitting source that is disposed laterally with respect to the liquid crystal display panel with the light source part for stereoscopic image display in the central portion and the light source part for viewing angle enlargement at

both end portions, and that emits light linearly; central prisms, which increase brightness by narrowing the irradiation range of said linear light emitting source, are provided in the central portion of said linear light emitting source; and peripheral prisms having a different brightness from said central prisms are provided at both end portions of said linear light emitting source.

(0007)

The second invention is the first invention, wherein said linear light emitting source comprises a plurality of linearly disposed point light emitting sources, and said central prisms and said peripheral prisms comprise, in a one-to-one relationship to the point light emitting sources, a light input surface that allows light from said point light emitting sources to enter and a light output surface that outputs light that has entered through the light input surface and whereof the optical path has been corrected.

(0008)

The third invention is the second invention, wherein the light output surfaces of said central prisms and said peripheral prisms are formed without any gap therebetween.

(0009)

The fourth invention is the second invention, wherein said central prisms and said peripheral prisms are provided in a one-to-one relationship with respect to said point light emitting sources.

(0010)

The fifth invention is the second invention, wherein said central prisms and said peripheral prisms are provided separately for the central portion of said linear light emitting source and the two end portions of said linear light emitting source, and are formed integrally via the peripheries of the light output surfaces according to the required number of point light emitting sources.

(0011)

The sixth invention is the second through fifth invention, wherein said point light emitting sources are arranged at a high density in the central portion of said linear light emitting source and at low density at both end portions of said linear light emitting source.

(0012)

The seventh invention is the first through sixth invention, wherein said central prisms and said peripheral prisms are fashioned as wedge shaped prisms having a light input surface facing said point light emitting sources and a light output surface facing the liquid crystal display panel surface, wherein the shape of at least one of the opposing side surfaces of said wedge shaped prism with respect to the liquid crystal display panel is made into a curved surface.

(0013)

The eighth invention is the seventh invention, wherein the shape of the other of the opposing side surfaces of said wedge shaped prism is made into a flat surface.

(0014)

The ninth invention is the first through sixth invention, wherein the light output surfaces of said central prisms and said peripheral prisms are formed so as to be located substantially equidistantly facing the central portion of said liquid crystal display panel.

(0015)

The tenth invention is a light source unit that comprises a light source part for frontal viewing in the central portion and a light source part for view field enlargement at both end portions, and that linearly emits light, and irradiates light from behind onto a liquid crystal display panel via an optical means that refracts light and irradiates it onto the liquid crystal display panel, wherein central prisms, which increase brightness by narrowing the irradiation range of said linear light emitting source, are provided in the central portion of said linear light emitting source, and peripheral prisms having a different brightness from said central prisms are provided at both end portions of said linear light emitting source.

(0016)

(EFFECT OF THE INVENTION)

In the first invention, a linear light emitting source is employed that is disposed laterally with respect to the liquid crystal display panel with the light source part for stereoscopic image display in the central portion and the light source part for viewing angle enlargement at both end portions, and that emits light linearly; central prisms, which increase brightness by narrowing the irradiation range of the linear light emitting source, are provided in the central portion of the linear light emitting source; and peripheral prisms having a different brightness from the central prisms are provided at both end portions of the linear light emitting source, thereby making it possible to advantageously utilize a limited quantity of light for stereoscopic image display and for view field enlargement. Therefore, the central portion of the display screen that enables stereoscopic viewing can be made brighter and the horizontal viewing angle can be increased while reducing the cost for securing the light source and the amount of heat generated by the light source.

(0017)
In the second invention, the linear light emitting source comprises a plurality of linearly disposed point light emitting sources, and the central prisms and peripheral prisms comprise, in a one-to-one relationship to the point light emitting sources, a light input surface that allows light from the point light emitting sources to enter and a light output surface that outputs light that has entered through the light input surface and whereof the optical path has been corrected, thereby making it possible to advantageously input light from the point light emitting sources and advantageously output light to the liquid crystal display panel.
(0018)
In the third invention, the light output surfaces of the central prisms and the peripheral prisms are formed without any gap therebetween, thereby making it possible to prevent shadows from appearing on the screen due to the gaps.
(0019)
In the fourth invention, the central prisms and peripheral prisms are provided in a one-to-one relationship with respect to the point light emitting sources, thereby making it possible to output light with reduced losses of the inputted light.
(0020)
In the fifth invention, the central prisms and peripheral prisms are provided separately for the central portion of the linear light emitting source and the two end portions of the linear light emitting source, and are formed integrally via the peripheries of the light output surfaces according to the required number of point light emitting sources, thereby making it possible to improve the assemblability of the prisms while outputting light with reduced losses of the inputted light.
(0021)
In the sixth invention, the point light emitting sources are arranged at a high density in the central portion of the linear light emitting source and at low density at both end portions of the linear light emitting source, thereby making it possible to reduce the amount of heat generated and to reduced costs by reducing the number of point light emitting sources. It also becomes possible to avoid concentration of heat generating locations.
(0022)
In the seventh invention, the central prisms and peripheral prisms are fashioned as wedge shaped prisms having a light input surface facing the point light emitting sources and a light output surface facing the liquid crystal display panel surface, wherein the shape of at least one of the opposing side surfaces of the wedge shaped prism with respect to the liquid crystal display panel is made into a curved surface, thereby making it possible to advantageously control the range of angles at which the outgoing light diffuses with respect to the liquid crystal display panel, and the luminous flux intensity distribution.
(0023)
In the eighth invention, the shape of the other of the opposing side surfaces of the wedge shaped prism is made into a flat surface, thereby permitting the outgoing light to diffuse with respect to the liquid crystal display panel and making it possible to widen the viewing angle in that direction. Furthermore, making the surface flat makes the machining easy and simplifies the polishing of the mirror surface for the purpose of reflecting light rays.
(0024)
In the ninth invention, the light output surfaces of the central prisms and peripheral prisms are formed so as to be located substantially equidistantly facing the center of the liquid crystal display panel, thereby making it possible to make the light source parts sparse while making the light output surfaces dense and allowing the concentration of heat generating parts to be prevented. This also simplifies the arrangement of the light source parts.
(0025)
In the tenth invention, which is a light source unit that comprises a light source part for frontal viewing in the central portion and a light source part for view field enlargement at both end portions, and that linearly emits light, and irradiates light from behind onto a liquid crystal display panel via an optical means that refracts light and irradiates it onto the liquid crystal display panel, central prisms, which increase brightness by narrowing the irradiation range of the linear light emitting source, are provided in the central portion of the linear light emitting source, and peripheral prisms having a different brightness from the central prisms are provided at both end portions of the linear light emitting source, thereby making it possible to advantageously utilize a limited light quantity for both frontal viewing and side viewing. Thus, it becomes possible to make the central portion of the display screen brighter and enlarge the horizontal viewing angle while reducing the costs of securing the light source and the amount of heat generated by the light source.
(0026)
(EMBODIMENTS OF THE INVENTION)
Embodiments of the present invention are described below based on the drawings.
(0027)

Figure 1 is an explanatory drawing of the functions of an image display device according to an embodiment of the present invention.
(0028)
Light source 201 comprises a light emitting source 210, a polarizing filter 212 (polarizing means), and a Fresnel lens 203 (optical means). The light emitting source 210 used here includes white light emitting diodes or the like (or cold cathode tubes or the like) disposed laterally. The polarizing filter 212 is configured to have different polarizations for light transmitted through the right area 212a and the left area 212b (for example, by shifting the polarization of transmitted light 90 degrees between the right area 212a and the left area 212b). The Fresnel lens 203 has a lens surface having depressions and projections concentrically on one side.
(0029)
Of the light emitted from the light emitting source 210, only light of certain polarizations is transmitted by the polarizing filter 212. Namely, out of the light emitted from the light emitting source 210, the light that has passed through the right area 212a of the polarizing filter 212 and the light that has passed through the left area 212b thereof are irradiated onto the Fresnel lens 203 as lights of different polarizations. As will be described later, the light that has passed through the right area 212a of the polarizing filter 212 reaches the left eye of the viewer, and the light that has passed through the left area 212b reaches the right eye of the viewer.
(0030)
The lights transmitted through the polarizing filter 212 are irradiated onto the Fresnel lens 203. The Fresnel lens 203 is a convex lens, and converts the optical path of the light emitted from the light emitting source 210 in a diffusing manner into substantially converged light, which is transmitted through a micro-retarder plate 204 and is then irradiated onto a liquid crystal display panel 205.
(0031)
At this time, the light irradiated from the micro-retarder plate 204 is emitted so as not to spread in the vertical direction, and is irradiated on the liquid crystal display panel 205. In other words, the light transmitted through a specified area of the micro-retarder plate 204 is transmitted through a specified display unit portion of the liquid crystal display panel 205.
(0032)
Furthermore, of the light irradiated onto the liquid crystal display panel 205, the light that has passed through the right area 212a of the polarizing filter 212 and the light that has passed through the left area 212b thereof enter the Fresnel lens 203 at different angles, are refracted in the Fresnel lens 203, and emitted from the liquid crystal display panel 205 along horizontally different routes.
(0033)
The liquid crystal display panel 205 is filled with liquid crystal oriented so as to be twisted by a prescribed angle (for example, 90 degrees) between two glass plates, and constitutes, for example, a TN (twisted nematic) type liquid crystal display panel. When no voltage is applied to the liquid crystal, the light that enters the liquid crystal display panel is emitted with the polarization of the incident light being shifted 90 degrees. On the other hand, when a voltage is applied to the liquid crystal, the liquid crystal becomes untwisted, so the incident light is emitted with unchanged polarization.
(0034)
The micro-retarder plate 204 and a polarizing plate 205a (second polarizing plate) are disposed on the light source 201 side of the liquid crystal display panel 205 (the combination of the micro-retarder plate 204 and the polarizing plate 205a (second polarizing plate) is referred to as a filter), and a polarizing plate 205b (first polarizing plate) is disposed on the viewer side.
(0035)
In the micro-retarder plate 204, areas that change the phase of transmitted light are disposed repeatedly at fine intervals. More specifically, on a light transmitting base material 230, there are arranged repeatedly, at fine intervals, areas 204a, each provided with a half-wave plate 231 of a fine width, and areas 204b, wherein no half-wave plate is provided, at the same fine intervals as the width of the half-wave plate 231. In other words, areas 204a that change the phase of transmitted light by means of the provided half-wave plates 231, and areas 204b that do not change the phase of transmitted light since no half-wave plates 231 are provided therein, are arranged repeatedly at fine intervals. The half-wave plates 231 function as the retarder plates that change the phase of the transmitted light.
(0036)

The half-wave plates 231 are disposed so that the optical axis thereof is inclined 45 degrees with respect to the polarization axis of the light transmitted through the right area 212a of the polarizing filter 212, and thus emit the light transmitted through the right area 212a with its polarization axis rotated 90 degrees. In other words, the polarization of the light transmitted through the right area 212a is rotated 90 degrees and made equal to the polarization of the light transmitted through the left area 212b. In other words, the areas 204b where the half-wave plates 231 are not provided transmit light that has passed through the left area 212b and has the same polarization as the polarizing plate 205a, while the areas 204a where the half-wave plates 231 are provided cause the light that has passed through the right area 212a and has a polarization axis orthogonal to the polarizing plate 205a to be rotated so as to become equal to the polarization axis of the polarizing plate 205a before the light is emitted.

(0037)

The repetition of the polarization characteristics of the micro-retarder plate 204 has substantially the same pitch as the units of display of the liquid crystal display panel 205, so that the polarization of the transmitted light differs for each unit of display (i.e. for each horizontal line in the lateral direction of the unit of display). Thus, the polarization characteristics of the micro-retarder plate corresponding to each horizontal line (scan line) of the display unit of the liquid crystal display panel 205 are different, and the direction of emitted light is different for each horizontal line.

(0038)

Alternatively, the repetition of the polarization characteristics of the micro-retarder plate 204 has a pitch that is an integer multiple of the pitch of the units of display of the liquid crystal display panel 504, so that the polarization characteristics of the micro-retarder plate 204 change for each set of multiple units of display (i.e. for each set horizontal lines of multiple units of display) and the polarization of transmitted light is configured to differ for each set of multiple units of display. Thus, the polarization characteristics of the micro-retarder plate differ for each set of multiple horizontal lines (scan lines) of the units of display of the liquid crystal display panel 504, and the direction of emitted light differs for each set of multiple horizontal lines.

(0039)

In this way, since it is necessary to irradiate different light onto the display elements (horizontal lines) of the liquid crystal display panel 205 for each repetition of the polarization characteristics of the micro-retarder plate, the vertical diffusion of the light that has been transmitted through the micro-retarder plate 204 and is to be irradiated onto the liquid crystal display panel 205 needs to be suppressed.

(0040)

Namely, the areas 204a of the micro-retarder plate 204, which change the phase of the light, make the light transmitted through the right area 212a of the polarizing filter 212 equal in polarization to the light transmitted through the left area 212b before transmitting it. Furthermore, the areas 204b of the micro-retarder plate 204, which do not change the phase of the light, allow the light that was transmitted through the left area 212b of the polarizing filter 212 to be transmitted as-is. Then, the light emitted from the micro-retarder plate 204, having the same polarization as the light transmitted through the left area 212b, enters the polarizing plate 205a provided on the light source side of the liquid crystal display panel 205.

(0041)

The polarizing plate 205a functions as the second polarizing plate, and has polarization characteristics that allow transmission of light having the same polarization as the light that has been transmitted through the micro-retarder plate 204. In other words, light that has been transmitted through the left area 212b of the polarizing filter 212 is transmitted through the second polarizing plate 205a, and the polarization axis of the light that has been transmitted through the right area 212a of the polarizing filter 212 is rotated 90 degrees before being transmitted through the second polarizing plate 205a. The polarizing plate 205b functions as the first polarizing plate, and has polarizing characteristics that allow light having a polarization differing from the polarizing plate 205a by 90 degrees to be transmitted therethrough.

(0042)

The micro-retarder plate 204, polarizing plate 205a, and polarizing plate 205b of this sort are bonded to the liquid crystal display panel 205, and the micro-retarder plate 204, polarizing plate 205a, liquid crystal display panel 205 and polarizing plate 205b are combined to constitute the image display device. Here, when voltage is applied to the liquid crystal, the light that has been transmitted through the micro-retarder plate 204 is transmitted through the polarizing plate 205b. On the other hand, when no voltage is applied to the liquid crystal, the light that has been transmitted through the micro-retarder plate 204 has its polarization twisted 90 degrees and is then emitted from the liquid crystal display panel 205, and hence is not transmitted through the polarizing plate 205b.

(0043)

A diffuser 206 is mounted on the front side (viewer side) of the first polarizing plate 205b, and functions as a diffusing means for vertically diffusing the light that has been transmitted through the liquid crystal display panel. More specifically, it vertically diffuses light that has been transmitted through the liquid crystal display

panel using a lenticular lens having semi-cylindrical protrusions and depressions provided repeatedly in the longitudinal direction.

(0044)

It is also possible to employ a matte diffusion surface with small protrusions and depressions formed on surface as a diffusing means. A rough surface is formed by providing numerous small oval or elongated circular projections on the surface, disposed so that their major axes are oriented substantially horizontally, and the matte finish is applied in a laterally flattened oval shape, which provides for strong vertical diffusion of light. It is also possible to provide the diffusing means on both surfaces of the diffuser to more strongly diffuse the light in the vertical direction. In this case, a lenticular lens and a matte diffusion surface may be combined as the diffusing means.

(0045)

Figure 2 and Figure 3 are a perspective view and an exploded perspective view of an image display device according to an embodiment of the present invention.

(0046)

Image display device 200 comprises a light source main body unit 250 having a light emitting source (linear light emitting source) 210 disposed in a holder 208 of prescribed shape, a reflecting plate (mirror) 202, a Fresnel lens 203, a micro-retarder plate 204, a liquid crystal display panel 205, a diffuser 206 and the like, which are assembled in a case 207.

(0047)

The light source main body unit 250 is mounted to a lower wall of a light source main body housing part 211 of the case 207 and is tilted rearward so that the linear light emitting source 210 is disposed laterally with respect to the liquid crystal display panel 205.

(0048)

The reflecting plate 202 is mounted to the upper half wall of the light source main body housing part 211 and is tilted forward so that the light from the linear light emitting source 210 is irradiated onto the Fresnel lens 203.

(0049)

The linear light emitting source 210 is disposed on the light source main body unit 250 in such a manner that the linear light emitting portions are curved toward the center of the Fresnel lens 203 (so as to be positioned at substantially equal distances) and are farther away than their focal distance (light from the linear light emitting source 210 and the distance from the central portion of the Fresnel lens 203 pass through the reflecting plate 202).

(0050)

The polarizing filter 212, which converts light from the right light emitting portion 210a of the linear light emitting source 210 into light having polarization for the left eye, and light from the left light emitting portion 210b of the same to light having polarization for the right eye, as will be described later, is mounted on the front surface of the light source main body unit 250.

(0051)

The Fresnel lens 203, the micro-retarder plate 204, the liquid crystal display panel 205 and the diffuser 206 are fitted to a panel frame 213 and a cover frame 214 of the case 207, and the panel frame 213 and the cover frame 214 are fixedly attached to the light source main body housing part 211. A light source main body cover 215 is affixed to the light source main body housing part 211 below the panel frame 213.

(0052)

A front cover 220 is mounted to the front surface of this display unit 216, and in the rear portion, a circuit board for driving is disposed in board holders 217, 218, and a cover case 221 is mounted. 222 is an air-cooling fan for the linear light emitting source 210.

(0053)

Figure 4 is a block diagram showing the drive circuit 600 of the image display device 200.

(0054)

A main control circuit 601 for driving the image display device is provided with a CPU 611, a ROM 612 preloaded with a program or the like, and a RAM 613, which is memory used as a work area when the CPU 611 is in operation. The CPU 611, the ROM 612 and the RAM 613 are connected by a bus 618. The bus 618 comprises an address bus and a data bus that are used for reading and writing of data by the CPU 611.

(0055)

A communication interface 615, an input interface 616, and an output interface 617, which coordinate input and output with the outside, are also connected to the bus 618. The communication interface 615 is a data

input/output unit for performing data communication according to a prescribed communication protocol. The input interface 616 and the output interface 617 input and output image data to be displayed on the image display device.

(0056)

A graphic display processor (GDP) 651 of display control circuit 602 is also connected to the bus 618. The GDP 651 performs computations on image data generated by the CPU 611, writes the data to a frame buffer provided in RAM 653, and generates signals (RGB, V BLANK, V_SYNC, H_SYNC) to be outputted to the image display device. ROM 652 and RAM 653 are connected to the GDP 651, and the RAM 653 is provided with a work area for the operation of GDP 651 and a frame buffer for storing the display data. The ROM 652 stores programs and data required for the operation of the GDP 651.

(0057)

Furthermore, a generator 658 that supplies a clock signal to the GDP 651 is connected to the GDP 651. The clock signal generated by the generator 658 defines the operating frequency of the GDP 651 and generates the frequency of the sync signals outputted from the GDP 651 (for example, V_SYNC and VBLANK).

(0058)

The RGB signal outputted from the GDP 651 is inputted into a γ correction circuit 659. The γ correction circuit 659 corrects the non-linear characteristic of illuminance with respect to the signal voltage of the image display device, adjusts the display illuminance of the image display device, and generates the RGB signal outputted to the image display device.

(0059)

A combining and converting device 670 is provided with a right eye frame buffer, a left eye frame buffer and a stereoscopic frame buffer, and writes the right eye image sent from the GDP 651 into the right eye frame buffer, and the left eye image into the left eye frame buffer. It then combines the right eye image and the left eye image to generate a stereoscopic image, and writes the same into the stereoscopic frame buffer, and outputs the stereoscopic image data to the image display device in the form of an RGB signal.

(0060)

Generation of the stereoscopic image by combining the right eye image and the left eye image is accomplished by combining the right eye image and the left eye image for each interval of the half-wave plates 231 of the micro-retarder plate 204. More specifically, since the half-wave plates 231 of the micro-retarder plate 204 of the image display device of the present embodiment are disposed at intervals of units of display of the liquid crystal display panel 205, the stereoscopic image is displayed such that the right eye images and the left eye images are alternately displayed on each horizontal line (scan line) of the units of display of the liquid crystal display panel 205.

(0061)

The left eye image data transmitted from the GDP 651 during L signal output is written to the left eye frame buffer and the right eye image data transmitted from the GDP 651 during R signal output is written to the right eye frame buffer. Then, the left eye image data written to the left eye frame buffer and the right eye image data written to the right eye frame buffer are read out for each scan line and are written to the stereoscopic frame buffer.

(0062)

The image display device has a liquid crystal driver (LCD DRV) 681 and a backlight driver (BL DRV) 682 provided therein. The liquid crystal driver (LCD DRV) 681 applies a voltage to the electrodes of the liquid crystal display panel in sequence based on the V_SYNC signal, H_SYNC signal and the RGB signal transmitted from the combining and converting device 670 to display a combined stereoscopic image on the liquid crystal display panel.

(0063)

The backlight driver 682 changes the duty ratio of the voltage applied to the backlight (light emitting source 210) based on the DTY_CTR signal outputted from the GDP 651, thereby changing the brightness of the liquid crystal display panel 205.

(0064)
Figures 5 through 8 are a plan view, a side view, an exploded perspective view, and a cross-sectional view of the light source main body unit 250. The linear light emitting source 210 is formed from a plurality of linearly arranged point light emitting sources (LEDs (light emitting elements): white light emitting diodes or the like) or an elongated cold cathode tube or the like; in this embodiment, the case where point light emitting sources are used will be described.
(0065)
The holder 208 comprises a split structure of storage cases 301a, 301b and a cover 302, which form the housing part 300 in the shape of a polygonal line. The housing part 300 includes a central portion 303 of a prescribed length, and peripheral portions 304 disposed at both ends thereof and sloped at a prescribed angle toward the front of the holder.
(0066)
The linear light emitting source 210 includes a prescribed number of LEDs (light emitting elements: white light emitting diode or the like) 305 linearly arranged on and attached to a central portion 308a of substrate 308 of a prescribed length, and peripheral portions 308b located at both sides thereof and sloped at a prescribed angle toward the front of the substrate.
(0067)
The LEDs 305 are arranged at narrower intervals (pitch A) on the central portion 308a of the substrate 308, and at wider intervals on the peripheral portions 308b. Here as well, in the peripheral portions 308b, the LEDs 305 that are closer to the center are disposed at narrower intervals (pitch B), while those toward the outside are arranged at wider intervals (pitch C). In this manner, the LEDs 305 in the central portion 308a, which is positioned in front of the viewer, are arranged at a higher density in order to make the display screen brighter. Furthermore, the LEDs 305 in the peripheral portions are intended to improve the horizontal viewing angle, and hence are disposed at a lower density, sacrificing brightness in order to avoid concentration of heat generating members and to reduce the cost by reducing the number of the LEDs.
(0068)
In front of the LEDs 305, prisms 306 that provide directionality to the light from the LEDs 305 are arranged in a one-to-one relationship to the LEDs 305. The prisms 306 on the central portion are integrally formed as a central prism element 307a and the prisms 306 on the peripheral portions are integrally formed as the peripheral prism elements 307b, corresponding to the LEDs 305 on the central portion 308a and the LEDs 305 on the peripheral portions 308b, and the light input surfaces (described later) for allowing light from the LEDs 305 to enter and the light output surfaces (described later) for outputting light that has entered through the light input surface and whereof the optical path has been corrected are provided in a one-to-one relationship with respect to the LEDs 305.
(0069)
Since the prisms 306 are provided in a one-to-one relationship with respect to the LEDs 305, the light entering the prisms can be outputted with reduced loss of light. Also, since the light input surfaces and the light output surfaces of the prisms are provided in a one-to-one relationship with respect to the LEDs 305, the light from the LEDs 305 can be advantageously inputted and advantageously outputted to the liquid crystal panel surface.
(0070)
Although the interval at which the LEDs 305 are arranged has been divided here into the three stages of pitch A, pitch B, and pitch C, the pitch may be also varied in two stages or in a plurality of four or more stages. The pitch may also be set for each integrally formed prism, or the pitch may be set in multiple stages within an integrally formed prism in conjunction with the disposition direction.
(0071)
The substrate 308 on which the LEDs 305 are arranged is housed in the housing cases 301a, 301b of the holder 208, the central prism element 307a is matched up with the LEDs 305 of the central portion 308a, the peripheral prism elements 307b are matched up with the LEDs 305 on the peripheral portions 308b (matching up the light emitting surfaces of the LEDs 305 and the light input surfaces of the prisms 306 in a one-to-one relationship), and the polarizing filter 212 is mounted on the front surface of the prism elements 307a, 307b via the cover 302, thereby forming the light source main body unit 250.
(0072)
The linear light emitting source 210 is formed in a horizontally symmetrical polygonal line shape, with the LEDs 305 on the central portion 308a of the substrate 308 being made into a linear stereoscopic image display light

source part running parallel to the display surface of the liquid crystal display panel 205 and the LEDs 305 on the peripheral portions 308b of the substrate 308 being made into a view field enlargement light source part that enlarges the lateral view field with respect to the display surface of the liquid crystal display panel 205, and with the central prism element 307a and peripheral prism elements 307b having their light output surfaces curve toward the center of the liquid crystal display panel 205 (being located substantially equidistantly).

(0073)
The polarizing filter 212 has different characteristics between the right light emitting portion 210a of the linear light emitting source 210 and the left light emitting portion 210b thereof, the boundary between them being the center of the linear light emitting source 210, as shown in Figure 5. Therefore, when it is difficult to form the boundary between the left and right light emitting portions 210a, 210b, one may mount the same polarizing filter 212 to the front surfaces of the left and right light emitting portions 210a, 210b (the front surface of the prism elements 307a, 307b) as shown in Figure 9, and bond a prescribed wave plate 311 to one of them.

(0074)
Although the linear light emitting source 210 was formed with a single substrate, it is also possible to divide the substrate into a substrate for the linear central portion 308a, and substrates for the linear peripheral portions 308b, linearly arrange the LEDs 305 on the respective substrates to form the respective units, and dispose the plurality of linear light emitting source units in a polygonal line to form the linear light emitting source 210.

(0075)
In Figures 5 through 7, the housing cases 301a, 301b of the holder 208 are formed with an air intake port 320 and an exhaust port 321 for air cooling. To improve heat radiating characteristics, the substrate 308 used is comprised of an aluminum substrate and has a large surface area. By driving the air cooling fan 222 (see Figure 3), air sucked in through the air intake port 320 is made to flow from the peripheral portion 308b to the central portion 308a along both surfaces of the substrate 308, and is discharged through the exhaust port 321. The central portion 308a of the substrate 308 is provided with a notch 322 at which air that has flowed over the two surfaces of the substrate 308 is combined in the vicinity of the entrance to the exhaust port 321 in order to improve exhaust efficiency. Thus, the linear light emitting source 210 can be cooled adequately and efficiently.

(0076)
Figure 10 and Figure 11 are a perspective view and a plan view of a unit prism (lens body) 306, while Figure 12 and Figure 13 are drawings of the central prism element 307a and the peripheral prism element 307b viewed from the side of the light input surfaces.

(0077)
The prism 306 is formed into a wedge shape so as to prevent diffusion of light from the LED 305 that has entered through the light input surface 400 and to provide directionality thereto, so that the light is emitted from the light output surface 401 at a prescribed spread angle. The light input surface 400 constitutes the tip of the wedge, while the light output surface 401 is the back end of the wedge.

(0078)
As shown in Figure 10, light that has entered the prism 306 in a substantially straight manner from the LED 305 is emitted as-is from the light output surface 401, while light entering at or above a predetermined angle (shown by the arrow) is completely reflected from the side surface of the prism 306, and the majority of it is emitted from the light output surface 401 in directions of a prescribed angular range.

(0079)
The prisms 306 include first prisms 306a used for the central prism element 307a, and inner second prisms 306b and outer third prisms 306c used for the peripheral prism elements 307b.

(0080)
The size of light input surfaces 400 of the first prism 306a of the central prism element 307a, and of the inner second prism 306b and the outer third prism 306c of the peripheral prism elements 307b is made substantially the same as or slightly larger than the size of the light emitting surface of the LED 305.

(0081)
The vertical lengths H (in the vertical direction with respect to the liquid crystal display panel) of the respective light output surfaces 401 of the first prisms 306a of the central prism element 307a and the inner second prisms 306b and outer third prisms 306c of the peripheral prism elements 307b are made uniform. The lateral width KA

(in the lateral direction with respect to the liquid crystal display panel) of the light output surfaces 401 of the first prisms 306a of the central prism element 307a is made equal to the arrangement intervals (pitch A) of the LEDs 305 of the central portion 308a of the substrate 308, the lateral width KB (in the lateral direction with respect to the liquid crystal display panel) of the light output surfaces 401 of the inner second prisms 306b of the peripheral prism elements 307b are made equal to the arrangement interval (pitch B) of the inner LEDs 305 of the peripheral portions 308b of the substrate 308, and the lateral width KC (in the lateral direction with respect to the liquid crystal display panel) of the light output surfaces 401 of the outer third prisms 306c of the peripheral prism elements 307b are made equal to the arrangement intervals (pitch C) of the outer LEDs 305 of the peripheral portions 308b of the substrate 308. The relative dimensional relationship of the respective light output surfaces 401 is shown in Figure 14.

(0082)

Namely, the light output surface area is smallest for the first prism 306a of the central prism element 307a, with the light output surface area increasing from the first prism 306a of the central prism element 307a to the second prism 306b and the third prism 306c of the peripheral prism elements 307b, in that order. Therefore, the brightness of the light output surface of the first prism 306a of the central prism element 307a is higher than that of the second prism 306b and the third prism 306c of the peripheral prism elements 307b. In other words, the first prism 306a of the central prism element 307a narrows the irradiation range of the LEDs 305 of the central portion 308a, and simultaneously increases the brightness by reducing the light output surface area to within a range in which throughput of the luminous flux is not lost. Furthermore, the second prism 306b and the third prism 306c of the peripheral prism elements 307b narrow the irradiation range of the LEDs 305 of the peripheral portion 308b, and simultaneously enlarge the light output surface area.

(0083)

The central prism element 307a includes the required number of the first prisms 306a integrally formed via the peripheral portions of their light output surfaces 401, and the peripheral prism elements 307b includes the required number of second prisms 306b and third prisms 306c, integrally formed via the peripheral portions of their light output surfaces 401. Between the prisms 306a of the central prism element 307a and between the prisms 306b, 306c of the peripheral prism elements 307b, excepting the integrally formed portions, gaps are provided to allow complete reflection without loss inside the prisms.

(0084)

The upper and lower peripheral portions (portions on the upper and lower sides with respect to the liquid crystal display panel) of the light output surfaces 401 of the first prisms 306a on the central prism element 307a, and the upper and lower peripheral portions (portions on the upper and lower sides with respect to the liquid crystal display panel) of the light output surfaces 401 of the second and third prisms 306b, 306c of the peripheral prism elements 307b are formed with projections 404, and the central prism element 307a and the peripheral prism elements 307b are attached to the holder 208 by means of the projections 404.

(0085)

Here, the projections 404 on the central prism element 307a are formed with a positioning groove 410 at the center position (with respect to the lateral portion of the prism element 307a), and when mounting, the groove 410 is aligned with a positioning engagement part 316 formed at the central portion of the central prism element attachment part 315 of the housing cases 301a, 301b of the holder 208. Furthermore, the projections 404 on the peripheral prism elements 307b are formed with a positioning groove 411 at a position shifted from the center (the section near the end of the prism elements 307b), and when mounting, the groove 411 is aligned with a positioning engagement part 318 formed on the periphery of the peripheral prism element mounting part 317 of the housing cases 301a, 301b of the holder 208.

(0086)

Since the required number of prisms is integrally formed, the light source unit 201 can be formed easily. Also, the projections 404 make mounting on the holder 208 easy, and the positioning means makes it possible to appropriately mount the central prism element 307a at the prescribed attachment position on the central prism element attachment part 315 and the peripheral prism elements 307b at the prescribed attachment position on the peripheral prism element attachment part 317.

(0087)

The prisms 306a, 306b, 306c are each made into a wedge shape wherein the shape of the surfaces of the body portion, i.e. the top and bottom (with respect to the liquid crystal display panel) side surfaces 402 and the left and

right (with respect to the liquid crystal display panel) side surfaces 403 are formed with a linear shape (flat surface). However, as shown in Figure 15, the top and bottom (with respect to the liquid crystal display panel) side surfaces 402 may also be formed into a curved surface shape whereof the curvature changes from the light input surface 400 side to the light output surface 401 side, for example, a so-called Bezier curve surface.

(0088)

By forming the upper and lower side surfaces 402 of the prism 306 into such curved surfaces, even light that enters at a relatively large angle of incidence in comparison with the one shown in Figure 10 above, as shown in Figure 15, can be narrowed in it its emission range to the range of the liquid crystal display panel and can be properly emitted in directions within a prescribed angular range from the light output surfaces 401 through complete reflection at the side surfaces 402 of the prism 306, thereby improving the uniformity of illumination. Therefore, diffusion of outgoing light in the vertical direction (with respect to the liquid crystal display panel) can be advantageously suppressed. Such a curved surface is effectively used for the side surfaces that correspond especially to the narrower sides of the liquid crystal display panel. Furthermore, when the left and right side surfaces 403 of the prism are formed into a linear shape, the viewing angle can be widened in the lateral direction (with respect to the liquid crystal display panel) by the outgoing light, and machining such as polishing can be made easier.

(0089)

Figure 25 shows a modification of the central prism element 307a. Here, among the LEDs 305 of the stereoscopic image display light source part (the central portion 308a of the substrate 308), the irradiation range is narrowed for the LEDs 305 of the central portion, which are the most involved in stereoscopic viewing, and the irradiation ranges of the LEDs 305 of the peripheral portions are somewhat widened.

(0090)

Here, for the prisms 306a of the central prism element 307a, if XA1 is the lateral width (lateral with respect to the liquid crystal display panel) of the light input surface 400 of a prism A of the LEDs 305 of the central portion, YA1 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and SA is the light input surface area thereof, and if XB1 is the lateral width (lateral with respect to the liquid crystal display panel) of the light input surface 400 of a prism B of the LEDs 305 on the inner side of the peripheral portions, YB1 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and SB is the light input surface area thereof, and if XC1 is the lateral width (lateral with respect to the liquid crystal display panel) of the light input surface 400 of a prism C of the LEDs 305 on the outer side of the peripheral portions, YC1 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and SC is the light input surface area thereof, then YA1, YB1 and YC1 are made the same, and the relation $SA < SB < SC$ is satisfied. The degree of freedom with respect to the size that the light input surface can have relative to the irradiation range is greater than that for the size of the light output surface described below.

(0091)

If XA2 is the lateral width (lateral with respect to the liquid crystal display panel) of the light output surface 401 of a prism A of the LEDs 305 of the central portion, YA2 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and WA is the light output surface area thereof, and if XB2 is the lateral width (lateral with respect to the liquid crystal display panel) of the light output surface 401 of a prism B of the LEDs 305 on the inner side of the peripheral portions, YB2 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and WB is the light output surface area thereof, and if XC2 is the lateral width (lateral with respect to the liquid crystal display panel) of the light output surface 400 of a prism C of the LEDs 305 on the outer side of the peripheral portions, YC2 is the vertical length thereof (vertical with respect to the liquid crystal display panel) and WC is the light output surface area thereof, then XA2 and YA2 are made smaller to narrow the irradiation range of the LEDs 305 of the central portion while at the same time increasing the brightness of the central portion. Furthermore, XB2, YB2, XC2 and YC2 are increased to widen the light output surface area. Moreover, the relations $XB2 < XC2$, $YB2 = YC2$ and $WA < WB < WC$ are satisfied. Generally, when the light output surface area is increased, the irradiation range tends to become narrower, and may sometimes become smaller than the liquid crystal panel. In order to avoid this, the ratio of the light input and output surface areas or the shape of the side surfaces is controlled so as to increase the light output surface area and maintain an adequate irradiation range.

(0092)

Further, if the light output surface is made too large in the arrangement direction of the filter, the angular range of luminous flux entering the filter is increased so that the luminous flux passes through adjacent pixels of the liquid crystal display panel, increasing cross-talk as a result.

(0093)

Moreover, in this case, in order to make the arrangement interval (pitch AP) of prisms A small, and the arrangement intervals (pitches BP and CP) of prisms B and C larger in that order, the arrangement intervals of

the LEDs 305 in the central portion is made smaller and the arrangement intervals of the LEDs 305 in the peripheral portions are increased in sequence. Furthermore, in order to maintain uniformity when viewed at various angles from the viewer side, the light output surfaces of the prisms A, B, and C are preferably formed so as to be continuous.

(0094)

Figure 16 and Figure 17 are a side view and a plan view of the optical system of image display device 200.

(0095)

The case where a plurality of point light emitting sources (LEDs) is arranged linearly on the linear light emitting source 210 will be described. However, only the central portion of the LEDs 305 and the prisms 306 of the linear light emitting source 210 are shown in Figure 16, and the LEDs 305 and the prisms 306 of the linear light emitting source 210 shown by a dotted line are the apparent position. In Figure 17, the reflecting plate 202 is omitted, and the LEDs 305 and the prisms 306 of the linear light emitting source 210 are shown at the apparent positions.

(0096)

As shown in Figure 17, light emitted from the LEDs 305 of the left and right light emitting portions 210a, 210b is transmitted through the polarizing filter 212 and spreads radially.

(0097)

Light emitted from the LEDs 305 of the right light emitting portions 210a and transmitted through the right area 212a of the polarizing filter 212 (the center of the optical path is indicated with a dashed line) reaches the Fresnel lens 203, the directions of travel of the light is changed by the Fresnel lens 203, and the light is transmitted through the micro-retarder plate 204 and the liquid crystal display panel 205 and reaches the left eye zone.

(0098)

Since the LEDs 305 of the right light emitting portion 210a are arranged consecutively in the central portion (to the right of center) of the light emitting source 210, illuminance of the light reaching the left eye zone is increased. In other words, the light from the LEDs 305 of the light emitting portion 210a on the center side reaches area AL, and the light from the LEDs 305 of the light emitting portion 210a adjacent thereto is emitted to an area that significantly overlaps the area AL, and hence the light from the sequentially adjacent LEDs 305 of the light emitting portions 210a is emitted to sequentially overlapping areas. Therefore, sufficient light is irradiated onto the left eye zone.

(0099)

Light emitted from the LEDs 305 of the left light emitting portion 210b and transmitted through the left area 212b of the polarizing filter 212 (the center of the optical path is indicated with a dashed line) reaches the Fresnel lens 203, the direction of travel of the light is changed by the Fresnel lens 203, and the light is transmitted through the micro-retarder plate 204 and the liquid crystal display panel 205 and reaches the right eye zone.

(0100)

Since the LEDs 305 of the left light emitting portions 210b are arranged consecutively in the central portion (to the left of center) of the light emitting source 210, the illuminance of the light reaching the right eye zone is increased. In other words, the light from the LEDs 305 of the light emitting portion 210b on the center side reaches area AR, and light from adjacent LEDs 305 of the light emitting portion 210b is emitted to an area that significantly overlaps area AR, and in this way the light from sequentially adjacent LEDs 305 of the light emitting portion 210b is emitted to sequentially overlapping areas. Therefore, sufficient light is irradiated onto the right eye zone.

(0101)

Furthermore, the directionality of the light is enhanced by the prisms 306 of the light emitting portions 210a, 210b on the center side, and the brightness of the light output surfaces is high. Also, the density of arrangement of the LEDs 305 of the light emitting portions 210a, 210[b] on the center side is high. Consequently, sufficient brightness is ensured at the central portion and in front of the center of the liquid crystal display panel 205.

(0102)

The liquid crystal display panel 205 substantially equalizes the pitch of the scan lines of the liquid crystal display panel 205 and the pitch of repetition of the polarization characteristics of the micro-retarder plate 204, and irradiates light coming from different directions for each scan line pitch step of the liquid crystal display panel 205, emitting light in different directions.

(0103)

Light emitted from the LEDs 305 of the right light emitting portion 210a and transmitted through the right area

212a of the polarizing filter 212 is transmitted through the Fresnel lens 203, reaches the micro-retarder plate 204, is transmitted through areas 204a of the micro-retarder plate 204, where the polarization is rotated 90 degrees before emission (light that has been transmitted through the right area 212a is transmitted), and then passes through the liquid crystal display panel 205 and reaches the left eye zone. In other words, the left eye image displayed by the display elements at positions corresponding to areas 204a of the liquid crystal display panel 205 reaches the left eye.

(0104)
Since the areas 204b that are arranged alternately with the areas 204a of the micro-retarder plate 204 do not change the polarization of light, the light from the right area 212a of the polarizing filter 212 is not transmitted through the polarizing plate 205a of the liquid crystal display panel 205, i.e. the display elements (which display the right eye image) at positions corresponding to areas 204b of the liquid crystal display panel 205.

(0105)
The light emitted from the LEDs 305 of the left light emitting portions 210b and transmitted through the left area 212b of the polarizing filter 212 passes through the Fresnel lens 203, reaches the micro-retarder plate 204, passes through areas 204b of the micro-retarder plate 204 that transmit light of the same polarization as the left area 212b of the polarizing filter 212, passes through the liquid crystal display panel 205, and reaches the right eye zone. In other words, the right eye image displayed by the display elements at positions corresponding to areas 204b of the liquid crystal display panel 205 reaches the right eye.

(0106)
Since areas 204a, which are arranged alternately with areas 204b of the micro-retarder plate 204, change the polarization of light, the light from the left area 212b of the polarizing filter 212 does not pass through the display elements (which display the left eye image) at positions corresponding to the polarizing plate 205a of the liquid crystal display panel 205, i.e. areas 204a of the liquid crystal display panel 205.

(0107)
Also, since the linear light emitting source 210 comprising a plurality of linearly arranged LEDs 305 is disposed in the lateral direction with respect to the liquid crystal display panel 205, bright images can be provided.

(0108)
Furthermore, although cross-talk caused by passage of luminous flux through pixels corresponding to the above-described filter and adjacent pixels or by overlap of the right eye image and the left eye image due to birefringence or scattering on the Fresnel lens 203 or the liquid crystal display panel 205 may be generated, since the linear light emitting source 210 is arranged laterally, the cross-talk can be reduced.

(0109)
As described above, sufficient light is irradiated onto the left eye zone and the right eye zone by the right light emitting portion 210a and the left light emitting portion 210b of the linear light emitting source 210. In other words, a left eye image of sufficient brightness reaches the left eye zone, while a right eye image of sufficient brightness reaches the right eye zone. Therefore, even when the right eye image enters the left eye, or the left eye image enters the right eye due to the birefringence or scattering on the Fresnel lens 203 or the liquid crystal display panel 205, the difference in brightness from the left eye image, which reaches the left eye, or the difference in brightness from the right eye image, which reaches the right eye, relatively increases, and hence the cross-talk can be sufficiently reduced. Particularly, since sufficient brightness is ensured in front of the central portion of the liquid crystal display panel 205, cross-talk can further be reduced.

(0110)
Therefore, the viewer can easily recognize the three-dimensional image based on the right eye image and the left eye image, and hence stereoscopic vision can be easily achieved through three-dimensional perception based on the parallax of the two eyes.

(0111)
Furthermore, light from the light emitting portions 210a disposed in the right peripheral portion of the linear light emitting source 210 is emitted to the left of the left eye zone at a wide angle (area DL), and light from the light emitting portions 210b disposed in the left peripheral portion of the linear light emitting source 210 is emitted to the right of the right eye zone at a wide angle (area DR).

(0112)
Therefore, the viewing angle of the image display device increases. Consequently, when video games or the like are played with this image display device, or when this image display device is used as an image display device for a game machine (such as a pachinko machine), the image can be viewed not only by the player, but also by people around the player, which is advantageous.

(0113)
When the linear light emitting source 210 is comprised of a cold-cathode tube or the like, the density of the light emitting portions of the center side and in the peripheral portions will be the same, but a similarly bright screen can still be achieved, the cross-talk can be sufficiently reduced, and the viewing angle is increased.
(0114)
Figures 18 through 20 are a plan view, a side view, and an exploded perspective view of the light source main body unit 250 according to another embodiment. The linear light emitting source 210 is composed of a plurality of linearly arranged point light emitting sources (LEDs (light emitting elements): white light emitting diodes or the like) or an elongated cold-cathode tube or the like, but for the embodiment, a case where point light emitting sources are employed will be described.
(0115)
Holder 330 comprises split structure housing cases 332a, 332b and a cover 333, forming a housing part 331 in the shape of a polygonal line, and the housing part 331 is formed with a central portion 334 of a prescribed length, intermediate portions 335 disposed on the both sides of the central portion and sloping at a prescribed angle toward the front of the holder, and peripheral portions 336 disposed on the both sides of the intermediate portions and sloping at a prescribed angle toward the front of the holder.
(0116)
The linear light emitting source 210 includes a prescribed number of LEDs (light emitting elements: white light emitting diodes or the like) 305 that are linearly arranged and mounted on the substrate (not shown) at the central portion of a prescribed length, the intermediate portions disposed on the both sides and sloping at a prescribed angle toward the front surface of the substrate, and the peripheral portions disposed on the both sides thereof and sloping at a prescribed angle toward the front of the holder.
(0117)
The LEDs 305 are arranged in such a manner that the arrangement intervals (pitch A) of the LEDs 305 in the central portion of the substrate are small, the arrangement intervals (pitch B) of the LEDs 305 in the intermediate portions are slightly larger than that of the LEDs 305 on the central portion, and the arrangement intervals (pitch C) of the LEDs 305 of the peripheral portions are slightly larger still than that of the LEDs 305 of the intermediate portions.
(0118)
In front of the LEDs 305, prisms 306 that provide directionality to the light from the LEDs 305 are provided in a one-to-one relationship to the LEDs 305. The prisms 306 on the central portion are integrally formed as a central prism element 307a, the prisms 306 on the intermediate portions are integrally formed as an intermediate prism element 307b, and the prisms 306 on the peripheral portions are integrally formed as a peripheral prism element 307c, corresponding to the LEDs 305 of the central portion 308a, the LEDs 305 of the intermediate portions, and the LEDs 305 of the peripheral portions 308b, and the light input surfaces for allowing light from the LEDs 305 to enter and the light output surfaces for outputting light that has entered through the light input surface and whereof the optical path has been corrected are provided in a one-to-one relationship with respect to the LEDs 305.
(0119)
As shown in previously described Figure 10, Figure 11 or Figure 15, the prisms 306 are formed into a wedge shape that prevents diffusion of light from the LEDs 305, provides directionality, and cause the light to be emitted with a prescribed angular spread, and include first prisms 306a used for the central prism element 337a, second prisms 306b used for the intermediate prism elements 337b, and third prisms 306c used for the peripheral prism elements 337c.
(0120)
The light output surface area of the first prisms 306a of the central prism element 337a is smallest, with the light output surface area increasing from the first prisms 306a of the central prism element 337a, to the second prisms 306b of the intermediate prism elements 337b, and to the third prisms 306c of the peripheral prism elements 337c in that order.
(0121)
The substrate on which the LEDs 305 are arranged is housed in the housing cases 332a, 332b of the holder 330 and assembled so that the central prism element 337a is aligned with the LEDs 305 of the central portion, the intermediate prism elements 307b are aligned with the LEDs 305 of the intermediate portions, and the peripheral prism elements 307c are aligned with the LEDs 305 of the peripheral portions (so that the light emitting surfaces of the LEDs 305 and the light input surfaces of the respective prisms 306 have a one-to-one correspondence), and a polarizing filter 212 is mounted to the front surfaces of the respective prism elements 307a, 307b, and 307c via cover 333, thereby forming the light source main body unit 250.

(0122)
The linear light emitting source 210 is formed into the shape of a horizontally symmetrical polygonal line, and the central prism element 307a, the intermediate prism elements 307b and the peripheral prism elements 307c are formed so that the light output surfaces of the prisms curve toward the center of the liquid crystal display panel 205.
(0123)
Although the linear light emitting source 210 was formed with a single substrate, it is also possible to divide the substrate into a substrate for the central portion, substrates for the intermediate portions, and substrates for the peripheral portions, linearly arrange the LEDs 305 on the respective substrates to form the respective units, and dispose the plurality of linear light emitting source units in a polygonal line to form the linear light emitting source 210.
(0124)
As a result, the linear light emitting portions of the linear light emitting source 210 can be arranged so as to curve more toward the central portion of the Fresnel lens 203 (so as to be positioned substantially equidistantly) than in the previously described embodiment. The main purpose of the operation of the Fresnel lens 203 is to cause convergence of the luminous flux from the LEDs 305 of the central portion to the positions of the eyes of the viewer, secure the field of view, and effectively separate the left and right areas that enable stereoscopic vision at the viewing position. When the shape of the Fresnel lens 203 is configured in this manner, the convergence characteristics of the luminous flux entering from the peripheral portions of the linear light emitting source 210 deteriorate, which causes a reduction in light utilization efficiency. Since one of the causes of the deterioration of the convergence characteristics is curvature of the image surface of the Fresnel lens 203, it can be corrected by employing a curved arrangement as described above. The extent of curvature need not completely coincide with the curvature of the image surface, and may be set as appropriate in consideration of the convenience of arrangement or manufacture.
(0125)
Therefore, nonuniformity of brightness in the left eye zone and the right eye zone can be adequately reduced, efficient utilization of light becomes possible and recognition of the three-dimensional image can be made easier.
(0126)
Figures 21 through 23 are a plan view, a perspective view and an exploded perspective view of the light source main body unit 250 according to another embodiment. The linear light emitting source 210 comprises a plurality of linearly arranged point light emitting sources (LEDs (light emitting elements): white light emitting diode or the like) or an elongated cold cathode tube or the like, but for the embodiment, the case where point light emitting sources are used will be described.
(0127)
Holder 350 comprises split structure housing cases 352a, 352b and cover 353, and the housing cases 352a, 352b and cover 353 form a housing part 351 of an arcuate shape (curved line shape) of a prescribed curvature (in this example, the radius is equal to the focal distance of the Fresnel lens 203).
(0128)
For the linear light emitting source 210, a prescribed number of LEDs (light emitting elements: white light emitting diodes or the like) 305 are linearly arranged and mounted on a substrate (not shown) formed by bending into an arcuate shape (curved line shape) of a prescribed curvature (with the radius being equal to the focal distance of the Fresnel lens 203).
(0129)
The LEDs 305 are arranged at equal intervals, and prisms 306 that provide directionality to the light from the LEDs 305 are arranged on the front surface of the respective LEDs 305 in a one-to-one relationship with respect to the LEDs 305.
(0130)
As shown in previously described Figure 10, Figure 11 or Figure 15, the prisms 306 are formed into a wedge shape that prevents diffusion of light from the LEDs 305, provides directionality and causes the light to be emitted at a prescribed angular spread. In the upper and lower peripheral portions (portions on the upper and lower sides with respect to the liquid crystal display panel) of the light output surfaces 401 of the prisms 306, mounting projections 420 are formed, as shown in Figure 24.
(0131)
The substrate on which the LEDs 305 are arranged is housed in the housing cases 352a, 352b of the holder 350, the prisms 306 are matched up with the LEDs 305 by fitting the projections 420 into receiving grooves 354 on the front edge portion of the housing cases 352a, 352b, and a polarizing filter 212 (not shown) is mounted to the front surfaces of the prisms 306 via the cover 353, thereby forming the light source main body unit 250.

(0132)
The linear light emitting source 210 is formed so that the light output surfaces of the prisms 306 are located substantially equidistantly facing the center of the liquid crystal display panel 205 (so that they curve), in a horizontally symmetrical curved line shape.
(0133)
Compared to the previously described embodiments, this allows for an arrangement where the light emitting portions of the linear light emitting source 210 are located more equidistantly from the center of the Fresnel lens 203, and the linear light emitting source 210 and the viewer are in substantially conjugate positions.
(0134)
Therefore, nonuniformity of brightness in the left eye zone and the right eye zone can be reliably eliminated, and recognition of the three-dimensional image can be made even easier.
(0135)
For the prisms 306 corresponding to the LEDs 305 of the central portion of the substrate, the LEDs 30[5] of the intermediate portions and the LEDs 305 of the peripheral portions as in the above-described example, one may also use prisms of different shapes, e.g. different light output surface areas.
(0136)
In the embodiments described above, the linear light emitting sources 210 were illustrated as comprising a plurality of linearly arranged point light emitting sources (LEDs (light emitting elements): white light emitting diodes and the like). However, it is also possible to employ a cold cathode tube or the like, in which case the elongated cold cathode tube or the like may be formed into the shape of polygonal line or a prescribed arcuate shape (curved line shape).
(0137)
The embodiments disclosed here are illustrative in all respects and should not be construed to be restrictive. The scope of the present invention is indicated not by the above description but by the scope of patent claims, and is intended to encompass all modifications within the meaning and scope equivalent to the scope of patent claims.
(BRIEF DESCRIPTION OF THE DRAWINGS)
(FIGURE 1) is an explanatory drawing of the functions of an image display device according to an embodiment of the present invention.
(FIGURE 2) is a perspective view of the image display device.
(FIGURE 3) is an exploded perspective view of the image display device.
(FIGURE 4) is a block diagram of the drive circuit of the image display device.
(FIGURE 5) is a front view of a light source main body unit.
(FIGURE 6) is a side view of the light source main body unit.
(FIGURE 7) is an exploded perspective view of the light source main body unit.
(FIGURE 8) is a cross-sectional view of the light source main body unit.
(FIGURE 9) is a perspective view of a polarizing filter.
(FIGURE 10) is a perspective view of a prism unit.
(FIGURE 11) is a plan view of the prism unit.
(FIGURE 12) is a drawing of a central prism element viewed from the light input surface side.
(FIGURE 13) is a drawing of a peripheral prism element viewed from the light input surface side.
(FIGURE 14) is a drawing showing the relative size relationships of the light output surfaces of the prisms.
(FIGURE 15) is a plan view of a unit prism.
(FIGURE 16) is a side view of the optical system of the image display device.
(FIGURE 17) is a plan view of the optical system of the image display device.
(FIGURE 18) is a front view of the light source main body unit according to a second embodiment.
(FIGURE 19) is a side view of the light source main body unit.
(FIGURE 20) is an exploded perspective view of the light source main body unit.
(FIGURE 21) is a front view of the light source main body unit according to a third embodiment.
(FIGURE 22) is a perspective view of the light source main body unit.
(FIGURE 23) is an exploded perspective view of the light source.
(FIGURE 24) is a perspective view of a unit prism.

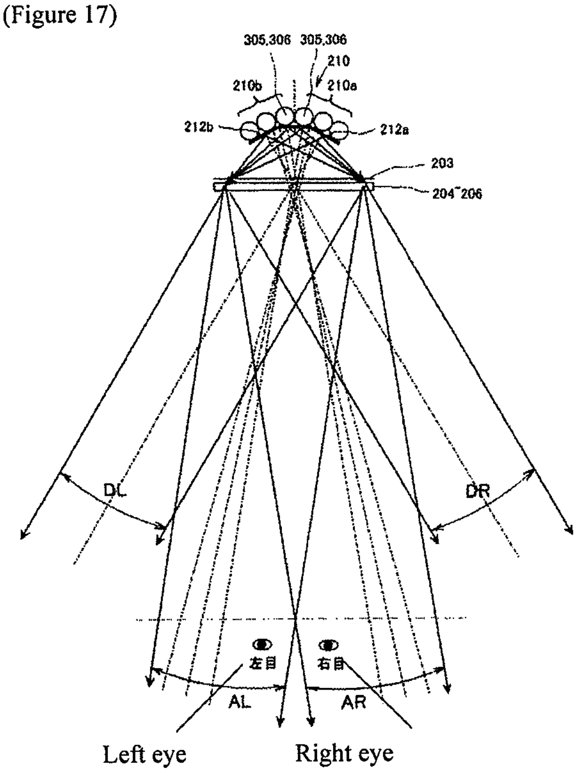
(FIGURE 25) is a drawing showing a modification of the central prism element.
(EXPLANATION OF REFERENCES)

201 Light source
202 Reflective plate (mirror)
203 Fresnel lens
204 Micro-retarder plate
205 Liquid crystal display panel
206 Diffuser
207 Case
208 Holder
210 Linear light emitting source
210a Right light emitting portion
210b Left light emitting portion
212 Polarizing filter
216 Display unit
250 Light source main body unit
300 Housing part
301, 301b Housing case
302 Cover
305 LED
306 Prism
306a First prism
306b Second prism
306c Third prism
307a Central prism element
307b Peripheral prism element
308 Substrate
330 Holder
331 Housing part
332a, 332b Housing case
333 Cover
337a Central prism element
337b Intermediate prism element
337c Peripheral prism element
350 Holder
351 Housing part
352a, 352b Housing case
353 Cover
400 Light input surface
401 Light output surface
404 Projection
600 Drive circuit

[see source for figures]

(Figure 4 captions)
200: Image display unit
601: Main control circuit
602: Display control circuit
615: Communication I/F
616: Input I/F
617: Output I/F
618: Bus
658: Generator
659: γ correction circuit
670: Combining and converting device

(Figure 17)



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